THE DEVONO-CARBONIFEROUS FAUNA OF THE SILVERBAND FORMATION, VICTORIA

By John A. Talent and D. Spencer-Jones

Abstract

The Silverband Formation is the only unit of the Grampians Group known to yield animal remains other than rather featureless burrows, trails and sphenopsid stems. The fauna is impoverished, consisting of a species of *Lingula*, 2 species of ostracods and a series of worm trails and fish remains: dermal denticles, spines and teeth. The fauna is diagnostic neither of the late Devonian nor of the Carboniferous, though none of the available meagre evidence conflicts with the Lower Carboniferous age long ascribed to these beds.

Introduction

As the stratigraphy and structure of the Grampians Group will be described elsewhere it will suffice merely to reiterate that the first fossils obtained from it were collected by W. H. Ferguson in 1913 from beds now included in the Silverband Formation. These were described by F. Chapman (1917) as:

Lingula squamiformis Phillips var. *borungensis* var. nov.
Physonemus attenuatus Davis
P. micracanthus sp. nov.
worm burrows.

A Lower Carboniferous age was ascribed to this assemblage. The fauna has been neither augmented nor revised since then, although the form identified as *P. attenuatus* has been since compared with *Erismacanthus* (Baird 1957) and some doubt has been expressed regarding the Carboniferous age of these beds (Benson 1923).

Extensive fossil collections have now been made at 11 new localities in the Grampians Group, thus requiring reassessment of the fauna of these sparingly fossiliferous sediments. Once again the only generically identifiable fossils have come from the top of the Silverband Formation, in a unit averaging about 180 ft in thickness, near the middle of the main Grampians Group succession (Table 1). In the present contribution the amassing of collections and stratigraphic information is due to D. Spencer-Jones; the illustrations, descriptive palaeontology and deductions therefrom are due to J. A. Talent.

Correlation and Palaeoecology

The fauna of the Silverband Formation (Table 2) is as follows:

Lingula borungensis (Chapman)
Ostracoda gen. & sp. indet. A
Ostracoda gen. & sp. indet. B
worm trails
'Physonemus' micracanthus Chapman
3 teeth of elasmobranch affinities
elasmobranch dermal denticles
unidentifiable fish spines.

TABLE 1

Grampians Group (Main Succession)

Formation	Unit	Lithologies	Thickness Ft	Fossils
Victoria Range Sandstones	2	Coarse, medium grained quartzose sandstones	3,500	Sphenopsid (stems)
	1	Coarse, medium and fine grained quartzose sandstones	5,500	
↑ ? Mt Difficult Sandstones		Medium and fine grained quartzose sandstones Quartzites	3,000	
Silverband Formation	3	Soft micaceous red siltstones and sandstones	180	*Lingula* sp., ostracods, fish spines, teeth, elasmobranch dermal denticles
	2	Medium grained quartzose sandstones	80	
	1	Soft red micaceous siltstones Medium grained quartzose sandstones	2,300	Animal burrows?
Red Man Bluff Sandstones	5	Medium to coarse grained quartzose sandstone	400	
	4	Soft red micaceous siltstones and sandstones	400	Animal burrows, Crustacean tracks
	3	Medium grained quartzose sandstones. Red micaceous sandstones and siltstones	1,150	
	2	Medium grained quartzose sandstones. Red micaceous siltstones.	400	
	1	Coarse to medium grained quartzose sandstones	3,600	

With the exception of the worm trails, the fauna is exclusively from unit 3 of the Silverband Formation. Animal burrows occur in unit 4 of the Red Man Bluff Sandstone at Fyans Cr. roughly 3,000 ft below the *Lingula* beds of unit 3 of the Silverband Formation. In addition there is a record of a possible crustacean trail from apparently the same formation at Talbot's Gap near Mt William (Ferguson 1917).

The fauna of unit 3 of the Silverband Formation is the only one known from the Grampians Group to have significant implications as regards correlation and depositional environment.

As elasmobranchs have not yet been found in beds older than Middle Devonian, the presence of elasmobranch dermal denticles is sufficient to fix a lower limit to the age of the formation. With the rejection of the determination of *Physonemus attenuatus* Davis and the certainty that *P. micracanthus* Chapman is not correctly assigned to *Physonemus*, the grounds for a Lower Carboniferous age for these beds becomes tenuous. *Lingula borungensis*, moreover, is not closely related to the late Devonian and Carboniferous species *L. squamiformis* Phillips. Though it is closer, for instance, to the Carboniferous species *L. mytilloides* Sowerby, it is such a comparatively featureless species that any inferences as regards intercontinental correlation would be hazardous. None of the fish remains nor *L. borungensis* has yet been recorded from better correlated Devonian and Carboniferous sequences in Australia. The fauna, therefore, is diagnostic neither of the Devonian nor of the Carboniferous, though none of the available evidence can be said to conflict with the Lower Carboniferous age long ascribed to these beds. Correlation with the other Devono-Carboniferous occurrences of SE. Australia must rest, for the present at least, on strong structural, lithologic and stratigraphic analogies.

The presence in the Silverband Formation of abundant *Lingula* and elasmobranch remains is clear evidence of a marine environment, at least for the beds containing these fossils. Indeed it could be argued from the presence of *Lingula* that the marine incursion was very shallow (Thomson 1927, Allan 1935, Craig 1952). Some (e.g. Allan) would contend the waters were warm temperate to tropical, though against such an interpretation is J. A. Thomson's contention that the present restriction of the genus to comparatively warm waters is a geologically recent event. The absence of brachiopods other than *Lingula* and the absence of other invertebrates, except for a very few worms and ostracods, is striking testimony to the unfavourable nature of bottom conditions to colonization by elements that would go to make up a normal marine fauna. The comparative abundance of fish remains on the other hand could indicate more normal marine surface waters.

Frederick Chapman (1917) visualized the *Lingula* shells as having 'drifted into small pools by tidal action'. Vigorous bottom activity is indicated by the completely dissociated and frequently broken nature of the fish remains and by the invariably disarticulated state of the ostracods and Lingulas. No Lingulas have been found in the living position, upright with the valves together. Such whole valves as occur are spread out along the bedding planes or occur haphazardly (usually broken) in the infilling of ?sun cracks (?animal burrows). The *Lingula* beds have been reworked to such a degree that the proportion of entire shells is often small compared with the amount of broken and comminuted shells. A notable exception was material from locality 3 which occurred in the form of a shell pavement of dissociated shells. The shells are close packed, often lying on top of one another and thereby contrasting with the overlying and underlying sediments in which Lingulas are comparatively rare. It is suggested this layering has resulted from the sluicing away of a layer of muddy sediment containing dead *Lingula* shells and that the shells were deposited as dissociated valves. That it was dead *Lingula* shells and not living ones which were so affected appears obvious. If a predominantly living population were uprooted one would expect many of the redeposited shells to be still held together by their muscles; that no paired shells were found shows this was not so.

Systematic Descriptions

Worm? Trails

(Pl. I, fig. 6)

F. Chapman (1917, p. 84) has recorded the presence of 'worm burrows filled with fine debris' associated with the Lingulas at locality 2. The presence of an

TABLE 2

Grampians Group Fossil Localities

Locality	One Mile Sheet Coordinates	Formation	Fossil Determinations
1	Stawell 466128	Silverband, Unit 3	*'Physonemus' micracanthus*, fish spine fragments indet.
2+	„ 457121	„ „	*Lingula borungensis*, *'P.' micracanthus*, fish spine fragments indet., fish tooth
3	„ 459118	„ „	*L. borungensis*, *'P.' micracanthus*, fish spine fragments indet., fish teeth
4	„ 481145	„ „	*L. borungensis*, *'P.' micracanthus*, fish spine fragments indet.
4*a*	„ 481124	„ „	*L. borungensis*, fish spine fragments indet.
5	„ 458156	„ „	*L. borungensis*, Ostracoda gen. & sp. indet. A
6	„ 467057	„ „	Ostracoda gen. & sp. indet. A and B
6*a*	12 ft stratigraphically above loc. 6	„ „	Elasmobranch dermal denticles
7	Grampians 275205	„ „	Ostracoda gen. & sp. indet. A
8	Ararat 501026	Red Man Bluff, Unit 4	Animal burrows
9	Stawell 479111	Silverband, Unit 1	Worm? trails
10	Thackeray 212873	Victoria Range	Moulds of sphenopsid stems
11	Wonwondah 411377	Silverband, Unit 3	Ostracoda gen. & sp. indet. A
12	Thackeray 415824	„ „	Fish spine indet.

+ Original locality of W. H. Ferguson, referred to as 'Mt Rosea' and near 'Halls Gap' by F. Chapman (1917).

occasional substantially whole Lingula shell in these 'burrowings' proves conclusively that the contents did not pass through the alimentary tract of a worm. The significance of the problematical structures will be discussed elsewhere by Spencer-Jones.

Comparatively featureless worm trails or castings are illustrated from unit 1 of the Silverband Formation.

Phylum BRACHIOPODA

Class INARTICULATA

Genus Lingula Bruguière

Lingula borungensis (Chapman)

(Pl. I, fig. 1-5; Fig. 1)

1914 *Lingula squamiformis* var. *borungensis* (nom. nud.) Chapman *Australasian Fossils* Melbourne, p. 261.

1917 *Lingula squamiformis* Phillips var. *borungensis* var. nov. Chapman *Rec. Geol. Surv. Vict.* 4 (1) : 86, Pl. 5, fig. 5.

DESCRIPTION : Shell of small size with valves subequal, the ventral slightly larger and more acuminate; outline elongate with a posterior acumination and moderately convex sides rounding progressively into a rather well rounded anterior margin; convexity rather low; surface ornament of very fine, sharp, concentric growth lirae, between 85 and 90 occurring in the space of 1 mm on well preserved specimens;

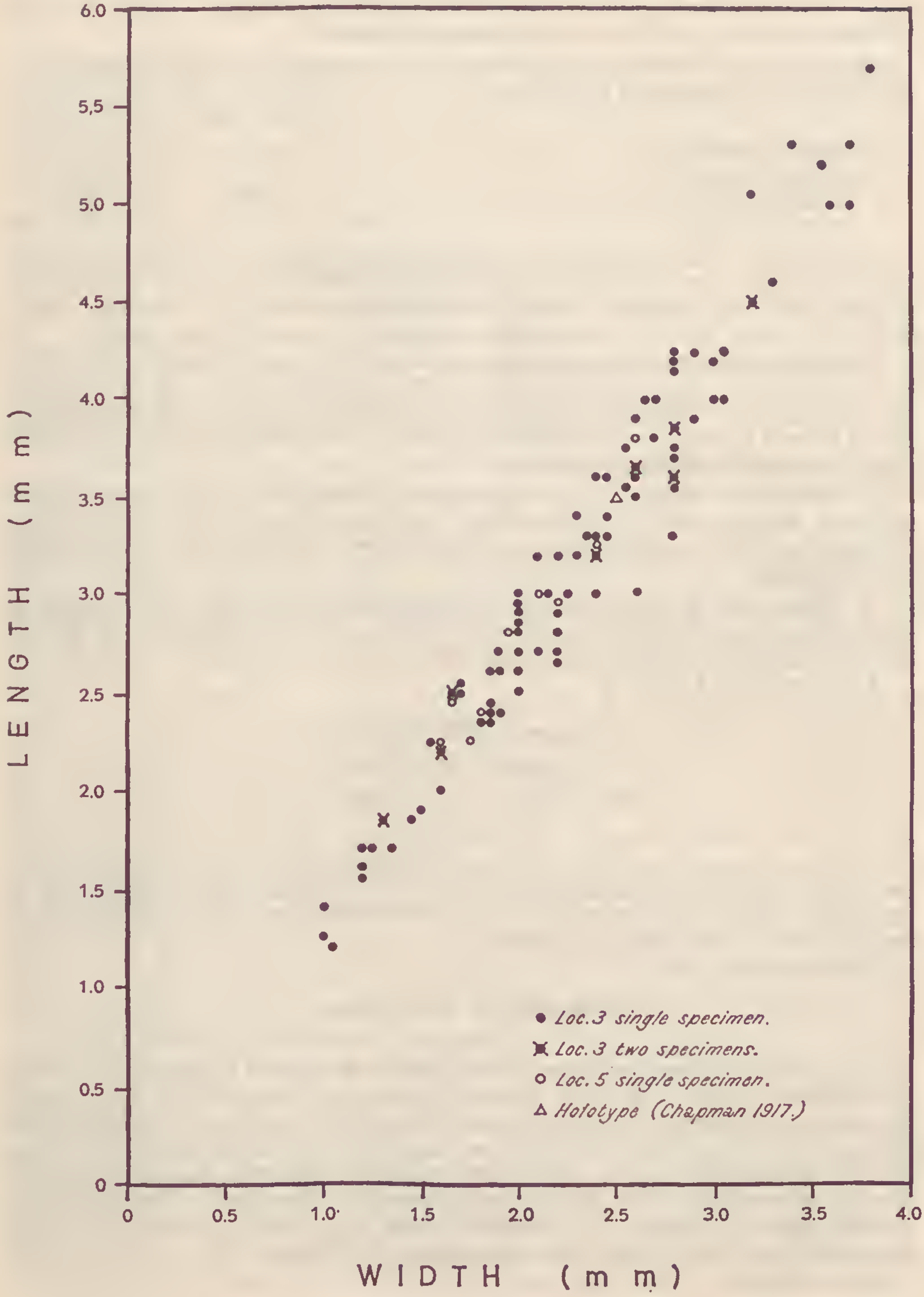

Fig. 1—Dimensions of specimens of *Lingula borungensis* (Chapman) from localities 3 and 5 of the Silverband Formation.

radial ornament absent; interior without defined musculature, septa or other distinctive features; shell thin and of unknown structure.

DIMENSIONS: 104 measured specimens from localities 3 and 5 are plotted as Fig. 1; there is no apparent dichotomy.

	length (mm)	width (mm)
largest specimen	5·7	3·8
smallest specimen	1·2	1·05
holotype (Chapman 1917)	3·5	2·25
mean dimensions	3·2	2·3

DISCUSSION: The graph (Fig. 1) shows the holotype to be slightly larger and proportionately narrower than average. Most available specimens were noticeably flattened, but three specimens showed a thickness of 0·4 mm for the single valve, so that the two valves in the associated state would be about 0·8 mm thick.

The holotype, formerly registered as Geological Survey of Victoria No. 12835, is now housed in the type collections of the National Museum of Victoria as No. P14362. It is rather badly crushed and somewhat distorted. The left postero-lateral margin is missing and the umbo appears to have been broken off, giving in effect an undue rectangular appearance.

L. borungensis differs from *L. squamiformis* Phillips in outline, surface ornament and, most noticeably, in dimensions. The dimensions of *L. squamiformis* are 10 times those of *L. borungensis*, so its body volume would be of the order of 1,000 times as great.

L. borungensis is much smaller, proportionately wider and less elliptical in outline than *L. mytilloides* Sowerby (cf. Deleers and Pastiels 1952); it has far more concentric lirae and is without the radii seen in *L. mytilloides*.

LOCALITIES: 2, 3, 4, 4a, 5.

Phylum ARTHROPODA

Subclass OSTRACODA

Ostracoda gen. & sp. indet. A

(Pl. II, fig. 1)

Poorly preserved, invariably disarticulated, ovate ostracods up to 3 mm long and 2 mm high are comparatively common at 4 localities. Generic assignment is impossible due to the absence of accurate information on relative size of valves, degree of overlap, and surface ornament.

LOCALITIES: 5, 6, 7, 11.

Ostracoda gen. & sp. indet. B

(Fig. 2)

Two large ovate ostracods from locality 6 differ in ratio of length to height from the ostracods identified above as Ostracoda indet. A. Excavation of one specimen revealed a canoe-shaped hinge depression like that of *Pruvostina* or *Paraparchites*, but an attempt to excavate the corresponding hinge depression of the other valve was not successful. Generic assignment is again impossible due to absence of accurate information on the relative size of the valves, the degree of overlap if any, and the nature of the surface ornament. There is no trace, for instance, of the surface pitting or reticulation that characterizes *Pruvostina*.

LOCALITY: 6.

Phylum CHORDATA

Subphylum Pisces

The fish fauna of the Silverband Formation consists of 3 types of remains: a series of dermal denticles from one locality, a series of fish spines from 6 other localities, and 3 teeth found in close association with the spines of 2 localities. As the dermal denticles have not been found in association with the other remains they cannot be construed as parts of the same organism. However the close association of the spines and teeth in these poorly fossiliferous beds leads one to suspect they were derived from the same species of fish.

Genus **Physonemus** McCoy 1848

'Physonemus' micracanthus Chapman

(Pl. II, fig. 4-8; Fig. 3)

1917 *Physonemus micracanthus* sp. nov. Chapman *Rec. Geol. Surv. Vict.* 4 (1): 84, 85, Pl. 5, fig. 1-3.
1917 *Physonemus attenuatus* Davis. Chapman *Ibid.*: 85, 86, Pl. 5, fig. 4.
1917 *Physonemus* sp. Chapman *Ibid.*: 86 (at least in part).

Description: Weakly arcuate, assymetrical spines up to about 5 mm in length; surface ornament of numerous (3 to 5 per mm) rounded longitudinal ridges separated by rather narrower interspaces, the anterior ridges tending to dilate regularly into rounded tuberculae, becoming in the nature of simple thorn-like spines towards the anterior margin; ornament occurring alike on the exserted and what is thought to be the inserted portion of the spine; increase of ridges by addition at the anterior (convex) margin and by rare branching; internal cavity opening near the base on the concave (posterior) portion of the spine, much as in *Ctenacanthus.*

Discussion: There were 10 incomplete spines in the Ferguson collection from locality 2, variously identified by Frederick Chapman as *Physonemus attenuatus* Davis, *P. micracanthus* sp. nov. and *P.* sp. Though spines were found at 6 localities during the present investigation they were invariably incomplete, adding little to our knowledge of the fishes which bore them. It is necessary neverthcless to reconsider the affinities of the form identified as *P. attenuatus* and to reconsider the generic location of *P. micracanthus.*

The specimen identified as *P. attenuatus by* Chapman is now No. P14363 in the type collections of the National Museum of Victoria. It is about 26 mm long and about 7 mm wide across the base. It was formerly broken in two at right angles to the spine and has been glued together. The break along the spine was through solid bone in the upper two-thirds revealing nothing of the surface ornament nor of the internal cavity. The surface ornament is revealed in the lower third, there being 21 longitudinal ridges at the lower extremity of the spine. There is close correspondence between the lower part of this specimen and the lower parts of the larger spines in the present collections (e.g. Pl. II, fig. 6-8). The upper parts of these specimens have precisely the same ornament and taper as the type specimens of *P. micracanthus,* which, moreover, are clearly broken spine tips. It is very likely that clearing of the bone from the upper two-thirds of the specimen identified as *P. attenuatus* would reveal the longitudinal ornament continuing towards the tip. There is little doubt then that the spines identified by Chapman as *P. micracanthus* and *P. attenuatus* came from the same species of fish. This fish could not have been *P. attenuatus* as the type and only specimen figured by J. W. Davis (1883, Pl. 47.

fig. 10) is strongly bent, much more attenuate and more than 5 times as large as the slightly arcuate specimen so identified by Chapman. Identification is made even more difficult in that the base of the type specimen of *P. attenuatus* has been broken off and most of the spine is decorticated except near its longitudinally striated tip.

The holotype of *P. micracanthus* is No. P14364 and the paratype No. P14365 in the type collections of the National Museum of Victoria. The paratype is more slender and less falcate than the holotype.

All the larger spines in the present collection have been etched in hydrochloric acid. These show the characteristic ornament extending without interruption from the base to the tip of the spine. It would appear there is no differentiation between exsert and insert portions of these spines though there is always the possibility that even the largest specimens have been broken off above the inserted portion. However that may be, no parts of spine have been found with a differing type of ornament which could be suggested as inserted portions. The larger spines show the internal cavity opening towards the concave side (Fig. 3; Pl. II, fig. 7) near the base and for a considerable distance along this margin.

The following features of the spines can be construed as being of generic importance: the lack of bilateral symmetry, the apparent lack of a smooth inserted portion and the presence of an internal cavity opening towards the concave margin.

The spines do not belong in *Physonemus* McCoy as that genus should be restricted to longitudinally ridged forms having a smooth inserted portion and having the medullary cavity of the spine opening towards the convex margin, i.e. having the spine arched forwards in contrast with most ichthyodorulite genera. Donald Baird (1957) has considered *P. attenuatus* Chapman *non* Davis to have similar shape to *Erismacanthus* McCoy, but this generic name should be restricted to spines like the type species, *E. jonesi* McCoy, bifurcating into slender branches. The non-marine Upper Devonian genus *Striacanthus* Hills (1931) has longitudinal ridges extending on to the inserted portion, but these ridges are not knotted, and the medullary cavity of this form is not known to open towards the concave margin as it does in *'P.' micracanthus*.

In the literature available to me in Australia I have been unable to find a generic name which could be used to accommodate this species. Rather than erect a new generic name for it I have preferred to leave the species as *incertae sedis* in *Physonemus* until such time as better material, or preferably a more intergrated organism, is to hand.

LOCALITIES: 1, 2, 3, 4, 4a.

Unidentifiable Fish Spines

The collections contain small scraps of fish spine, too incomplete or too poorly preserved for certain identification as *'P.' micracanthus*, though there is no good reason for considering any other species of fish to be represented by these spines.

LOCALITIES: 1, 2, 3, 4, 4a, 12.

Fig. 2—Outline and profile of Ostracoda gen. & sp. indet. B, GSV 54613, x 12·5, from locality 6 of the Silverband Formation. The profile of the hinge depression or possible overlap is shown in the second figure.

Fig. 3—Cross sections x 12·5 of a spine of *'Physonemus' micracanthus* Chapman, showing the assymmetry and the medullary cavity opening towards the back; locality 2 of the Silverband Formation.

Fig. 4—Elasmobranch dermal denticles from locality 6a of the Silverband Formation, x 50 approximately.

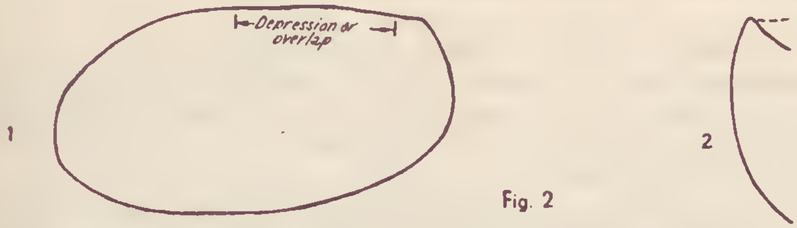

Fig. 2

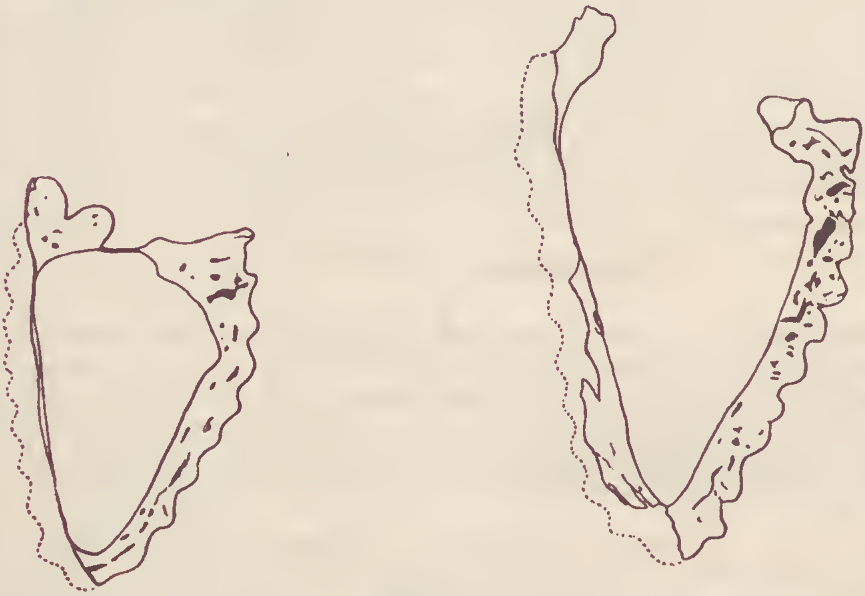

Fig. 3

Fig. 4

Elasmobranch Teeth

(Pl. II, fig. 2, 3, 8)

DESCRIPTION: 3 solitary teeth, the largest about 5 mm in length, all firmly embedded in matrix and broken to show 4 cusps; 2 cusps directed more or less vertically, one inclined 'anteriorly' at about 45° and the other inclined 'posteriorly' at about 60° to the vertical, the arrangement of the cusps having the appearance of a small cemented whorl of shark teeth.

DISCUSSION: The randomness of the sections through these teeth and the resistance to attempts to clear them with acids prevents formulation of a satisfactory picture of their appearance in 3 dimensions. One specimen, from locality 2, occurs alongside the specimen identified by Chapman as *P. attenuatus* (National Museum of Victoria No. P14363). It is about 3 mm long, differing from the largest specimen here illustrated (Pl. II, fig. 2, 3) in having a very small 'anterior' cusp. This may well be due to the angle of fracture. The fourth specimen, now more or less destroyed by attempts to clear it with acids, was approximately the same size and shape as the second specimen here illustrated (Pl. II, fig. 8).

LOCALITIES: 2, 3.

Elasmobranch Dermal Denticles

(Fig. 4)

DESCRIPTION: Small, almost bilaterally symmetrical, trilobate, tricuspate tooth-like structures up to 0·9 mm in length and 0·4 mm in width; cusps sharply pointed with central cusp considerably longer and stronger than lateral cusps; median lobe much wider and stronger than lateral lobes and generally having a flattened upper surface bearing a shallow median depression; grooves between lobes with flatly rounded bottoms; occasional specimens showing a further incipient pair of cusps (Fig. 4A).

DISCUSSION: Descriptions of Devonian and Carboniferous sharks contain occasional mention of the presence of patches of dermal denticles, but there are few descriptions or figures of individual denticles. Tricuspate dermal denticles, for instance, are by no means uncommon. They have been figured by B. Dean (1909) for the Upper Devonian cladoselachian *Cladoselache fyleri* Dean and by A. S. Woodward (1902) for the Lower Carboniferous hybodontoid *Tristychius arcuatus* Agassiz and the Upper Jurassic heterodontoid *Heterodontus falcifer* Wagen. There is little doubt that the denticles belong to a shark-like fish either of the order of Cladoselachii or the order Selachii, but no further precision can be attempted as to its generic affinities. Having regard to the inherent variability of dermal denticles on different parts of the body of a shark, no attempt at naming them as parataxa appears justified.

The denticles are poorly preserved and difficult to extract.

LOCALITY: 6a.

Acknowledgement

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Cited Literature

ALLAN, R. S., 1935. New records of *Lingula* from the Tertiary of New Zealand. *Roy. Soc. N.Z. Trans. & Proc.* 65: 383-5.

Baird, D. W., 1957. A *Physonemus* spine from the Pennsylvanian of West Virginia. *Jour. Palaeontology* 31: 1010-8.

Benson, W. N., 1922. Materials for the study of the Devonian palaeontology of Australia. *Geol. Surv. N.S.W. Rec.* 10 (2): 83-204, in particular p. 204.

———, 1923. Palaeozoic and Mesozoic seas in Australasia. *N.Z. Institute Trans.* 54: 1-62, in particular p. 28.

Chapman, F., 1917. On the occurrence of fish remains and a *Lingula* in the Grampians, Western Victoria. *Geol. Surv. Vict. Rec.* 4: 83-86, Pl. 5.

Craig, G. Y., 1952. A comparative study of the ecology and palaeoecology of *Lingula*. *Edinburgh Geol. Soc. Trans.* 15: 110-120.

Davis, J. W., 1883. On the fossil fishes of the Carboniferous limestone series of Great Britain. *Roy. Dublin Soc. Trans.* (ser. 2) 1: 327-600, Pl. 42-65.

Dean, B., 1909. Studies of fossil fishes (sharks, chimaeroids, and arthrodires). *Amer. Mus. Nat. Hist. Mem.* 9: 222-287, Pl. 26-41, 65 fig.

Deleers, C., and Pastiels, A., 1952. Contribution a l'étude de *Lingula mytilloides* Sowerby du Westphalien de la Belgique. *Assoc. Etudes Palaeontol. Stratig. Houill.* Pub. 12: 65 p.

Ferguson, W. H., 1917. The discovery of fossils in the Grampians sandstones with general notes on the formation. *Geol. Surv. Vict. Rec.* 4: 5-9.

Hills, E. S., 1931. The Upper Devonian fishes of Victoria, Australia and their bearing on the stratigraphy of the State. *Geol. Mag.* 68: 209-231, Pl. 11.

Thomson, J. A., 1927. Brachiopod morphology and genera (Recent and Tertiary). *N.Z. Board Sci. & Arts* Manual 7: 1-338, Wellington.

Woodward, A. S., 1902. Pisces *in* Zittel, K. A. *Textbook of Palaeontology* 2: 2-114, Macmillan and Co., London.

Explanations of Plates

Plate I

Fig. 1-5—*Lingula borungensis* (Chapman). 5 specimens showing the morphology, the more acuminate and less acuminate forms (? pedicle and brachial valves respectively) and the close spacing of the concentric growth lirae; fig. 1, 2, 5—x 18, fig. 3, 4—x 10. All specimens are from locality 3 and are GSV 54892-46, 54892a-1, 57900, 57902 and 54891-1 respectively.

Fig. 6—Worm? trails. Loc. 9, Silverband Formation, unit 1, x 1.

Plate II

Fig. 1—Ostracoda gen. & sp. indet. A. Moulds of carapaces, x 3; specimen GSV 54898 from locality 7.

Fig. 2, 3—Elasmobranch tooth, counterparts GSV 58219 and 58218 respectively; locality 3; x 5.

Fig. 4-7—*Physonemus micracanthus* Chapman. Moulds of spines, x 5; specimens GSV 5447a, 5447b from locality 1 and GSV 57826 and 57827 from locality 2 respectively.

Fig. 8—*Physonemus micracanthus* Chapman and mould of an elasmobranch tooth, GSV 13100, locality 2, x 5.